Management of Asymptomatic Popliteal Artery Aneurysms

Tanner I. Kim, MD[1] Bauer E. Sumpio, MD, PhD, FACS[1]

[1] Division of Vascular Surgery, Department of General Surgery, Yale University, New Haven, Connecticut

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Address for correspondence Bauer E. Sumpio, MD, PhD, FACS, Division of Vascular Surgery, Department of General Surgery, Yale University, 330 Cedar Street, BB204C, New Haven, CT 06519 (e-mail: Bauer.sumpio@yale.edu).

Abstract

Popliteal artery aneurysms (PAAs) are the most common peripheral artery aneurysms. They are frequently symptomatic and are associated with high rates of morbidity and limb loss. PAA can be treated by open or endovascular means, although there are no specified recommendations guiding treatment choice. This article delineates many of the differences between open and endovascular repair of asymptomatic PAA, and highlights several key articles comparing open and endovascular repair to guide decision making. Proper diagnosis and choice of repair can lead to good outcomes in the treatment of asymptomatic PAA.

Keywords

- aneurysm
- artery
- endovascular procedure
- ischemia
- peripheral arterial disease
- popliteal aneurysm
- popliteal artery

A 68-year-old male with a history of hypertension, hyperlipidemia, diabetes mellitus, atrial fibrillation on anticoagulation, and prior left knee replacement presented with left lower extremity swelling. Examination revealed a prominent popliteal pulse, and ultrasound and computed tomography angiography revealed a popliteal artery aneurysm (PAA) measuring 6.5 × 5.6 × 5.0 cm within the popliteal fossa with compression of the popliteal veins (►**Fig. 1**). He underwent a preoperative angiogram demonstrating a large left PAA and two-vessel runoff. He was taken to the operating room for open repair of his PAA via posterior approach and placed in a prone position (►**Fig. 2**). A "lazy-S" incision was made over the popliteal fossa, and the tibial nerve and popliteal veins were identified (►**Fig. 3**). After obtaining proximal and distal control, the aneurysm was opened, geniculate branches were oversewn, and an 8-mm Propaten (W. L. Gore & Associates, Flagstaff, AZ) interposition graft was placed. The patient had an uneventful postoperative course and was discharged home.

Introduction

PAAs are uncommon, with an incidence of less than 0.1% in the general population, but account for over 70% of peripheral artery aneurysms.[1,2] PAAs are predominantly observed in males, with a mean age of 65 years old. They are bilateral in 50% of cases and associated with abdominal aortic aneurysms.[3] More than half of patients present with symptoms, most commonly some degree of acute limb ischemia secondary to thromboembolic complications, and are associated with high rates of morbidity and limb loss.[1,4–10] Less frequent symptoms include lower extremity swelling and pain secondary to mass effect on the surrounding nerve and venous structures. Rupture is a rare occurrence, although also associated with high rates of limb loss.[1,11,12] Observational studies have also shown that asymptomatic PAAs have a high likelihood of becoming symptomatic, with rates approaching 70% within 5 years.[6,13,14] Repair for PAA is indicated when greater than 2.0 cm in diameter or symptomatic. PAA can be repaired through open and endovascular approaches. The advent of endovascular interventions has led to an increase in stent graft placement for PAA and has challenged open repair as the gold standard treatment.[15,16] Although numerous studies have compared the two approaches, there is still no consensus on the preferred surgical management.

Open and Endovascular Repair of Asymptomatic PAA

Open Repair of Asymptomatic PAA

The open surgical management of PAA has existed for centuries. Lexer was the first to describe repair using a

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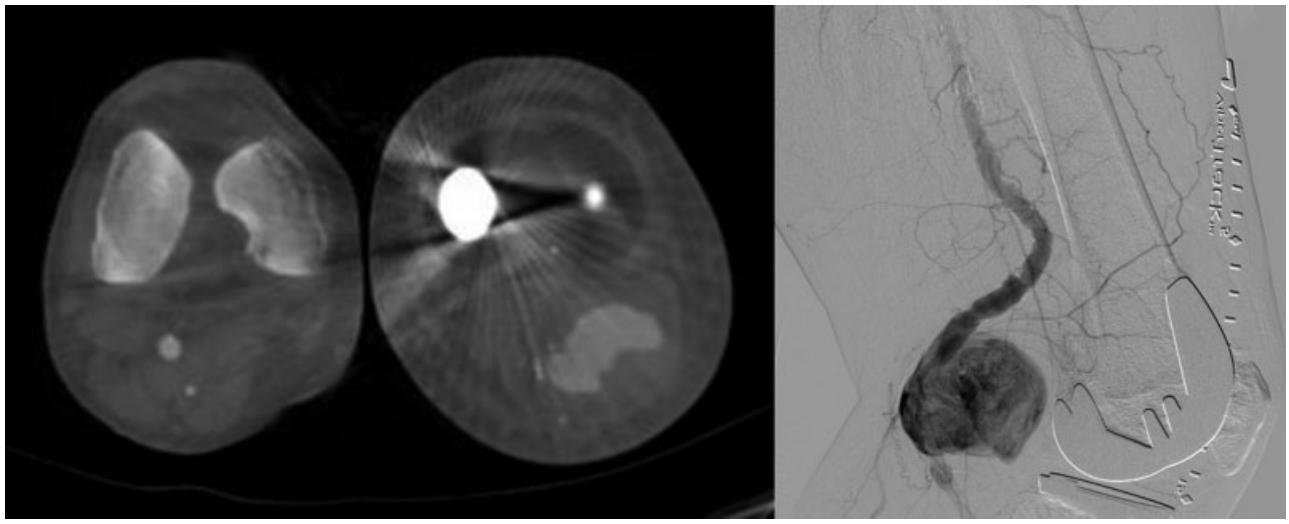

Fig. 1 Computed tomography angiography (CTA) demonstrating left lower extremity popliteal artery aneurysm (PAA). Preoperative angiogram demonstrating left lower extremity angiogram.

Fig. 2 Patient placed in prone position. All parts of the body are carefully positioned and padded.

posterior approach with aneurysm exclusion and venous interposition grafting, followed by Edwards in 1969, who described the medial approach with aneurysm ligation and vein bypass.[17,18]

The modern approach to surgical repair of PAA utilizes two frequently described techniques. The medial approach with the patient in a supine position is the most commonly performed and familiar to vascular surgeons. The greater saphenous vein can be easily accessed, and allows for the bypass to be extended proximally or distally to the tibial arteries if needed. Depending on the status of the PAA, proximal and distal ligation is usually performed if patent and not completely thrombosed. In a minority of cases, the aneurysm may continue to be pressurized by the geniculate arteries and continue to increase in size.[19,20] The posterior approach is commonly used for aneurysms causing compression by mass effect or for smaller aneurysms confined within the popliteal space. The patient is placed in a prone position, and a "lazy-S" incision is made over the popliteal fossa. The surrounding nerves and veins are identified and isolated. Control of the artery is obtained, and the aneurysm sac is opened. Geniculate branches are oversewn within the aneurysm sac, and an interposition graft with vein or prosthetic is made. Multiple studies have found no overall difference between the two approaches, while some have demonstrated improved patency and decreased incidence of aneurysm sac expansion with the posterior approach.[9,20–23]

Open repair has an abundance of data demonstrating its efficacy. Dawson et al reviewed open repair of 2,445 PAAs, with a 77 to 100% primary patency of saphenous vein grafts at 5 years.[1] Dorweiler et al reported the long-term results of open repair of 206 PAAs with a primary patency of 88.1 and 73.5% at 5 and 10 years, respectively.[24] It has been consistently demonstrated that venous conduit is superior to prosthetic conduit, with a series from the Mayo Clinic demonstrating a 5-year primary patency of 85% for venous

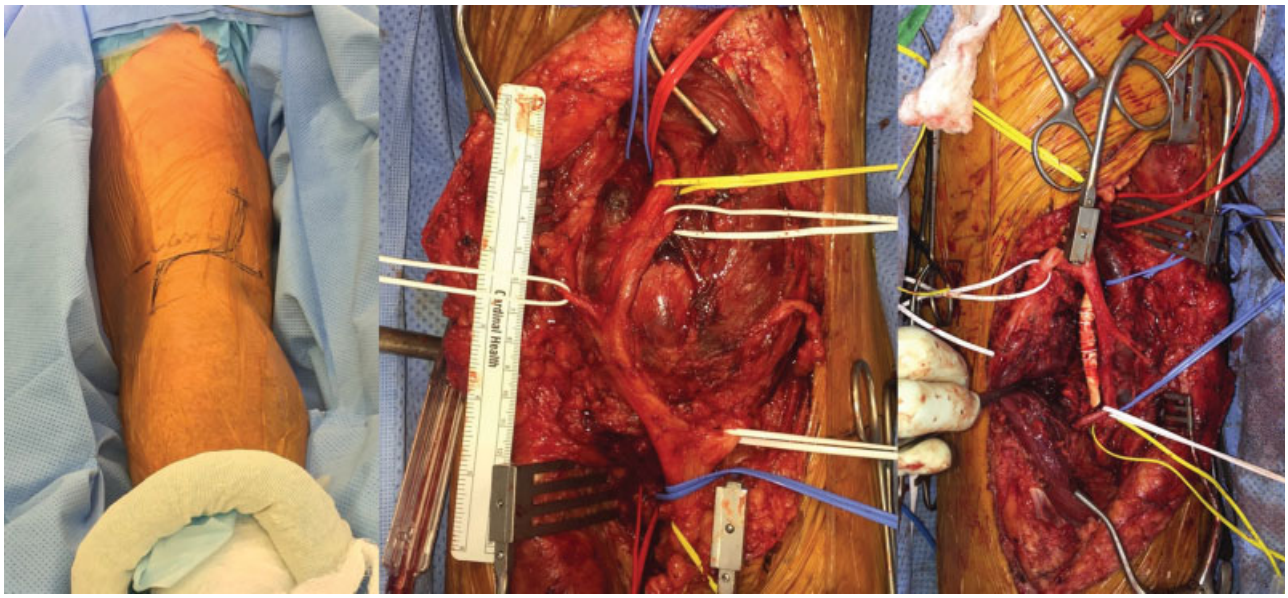

Fig. 3 "Lazy-S" incision marked over the popliteal fossa. Intraoperative exposure of large popliteal artery aneurysm (PAA) with the surrounding nerves and veins isolated. Interposition graft with Propaten (W. L. Gore & Associates, Flagstaff, AZ).

conduit compared with 50% for prosthetic.[21,25,26] Other risk factors for decreased patency include presence of symptoms, distal anastomosis, and poor runoff.[21,27,28] Overall perioperative mortality has been demonstrated to be 1 to 2%.[7,24,25,29] Complications, most commonly surgical site infection, hematoma, and thrombosis, occur at rates of up to 20% for asymptomatic PAA, and even higher for symptomatic patients.[24,25,30,31]

Endovascular Repair of Asymptomatic PAA

Marin et al first described endovascular repair of asymptomatic PAA with a covered stent in 1994.[32] Since then, endovascular repair of PAA has gradually increased over the past several decades. The most commonly used covered stent is the Viabahn Endoprosthesis (W. L. Gore & Associates, Flagstaff, AZ). The procedure is performed with cut-down or percutaneous access of the common femoral or superficial femoral artery. After access is obtained, an angiogram is performed to define the anatomy. A proximal and distal landing zone of at least 2.0 cm of normal artery is necessary for a proper seal. Multiple stent grafts may be necessary for adequate coverage, typically starting from distal to proximal with the smallest stent graft being deployed first. A completion angiogram is performed to evaluate for endoleaks and runoff. Patients are given a loading dose of clopidogrel and continued for a minimum of 4 to 6 weeks.

Multiple studies have demonstrated good short- and mid-term patency, although long-term data are limited. A meta-analysis of the Viabahn Endoprosthesis in asymptomatic PAA analyzed 514 PAAs treated with an endovascular stent graft.[33] At 5 years, primary and secondary patency were 69.4 and 77.4%, respectively. Multiple studies have demonstrated that poor inflow, distal runoff, smoking, and the absence of anticoagulation are risk factors for decreased patency.[34–36] Endoleaks may be observed in up to 20% of patients.[33,37] Endovascular repair should be avoided in younger, active patients who use knee flexion, as it has been associated with stent fractures.[38] Furthermore, endovascular repair is contraindicated with compressive symptoms or single-vessel runoff.

Comparison of Open and Endovascular Repair of PAA

There is no consensus on the optimal method of repair of PAA, although several retrospective reviews and meta-analyses have compared the results of both open and endovascular repair. Based on Centers of Medicare and Medicaid services Inpatient claims between 2005 and 2007, there has been a nearly twofold increase in endovascular repair of PAA, coinciding with a decrease in open repair.[15] There was no difference in the overall rate of complications, although open repair was associated with higher rates of cardiac and respiratory complications. Despite the shorter length of stay, endovascular repair was still associated with increased costs. In addition, endovascular repair had significantly higher rates of reintervention for embolectomy, thrombolysis, and angiography at 30 and 90 days. Almost all studies have shown that endovascular repair is associated with increased rates of graft thrombosis and reintervention compared with open repair.[15,21,25,39–42]

Eslami et al used the Vascular Quality Initiative database to compare 221 open and 169 endovascular repairs of asymptomatic PAAs.[39] At 1-year, open repair had significantly lower rates of reintervention and higher primary patency rates compared with endovascular repair. Complications were not recorded for endovascular repair although open repair had a complication rate of 11%. Huang et al compared open and endovascular repair for 149 PAAs, and demonstrated that elective endovascular repair resulted in

Table 1 Primary patency rates for open repair, endovascular repair, and optimal medical treatment, stratified by greater saphenous vein bypass (GSVB) or polytetrafluoroethylene (PTFE)

Group	Type	1 y, %	2 y, %	3 y, %	4 y, %	5 y, %
Open	Elective					
	GSVB	89	86	85	82	80
	PTFE	77	67	58	54	50
Stent	Elective	87	82	77	74	70
OMT	Stay asymptomatic	76	50	41	35	32

Abbreviation: OMT, optimal medical treatment.
Note: Adapted from Hogendoorn et al.[44]

Table 2 Advantages and disadvantages of open and endovascular repair of PAA

	Advantages	Disadvantages
Open repair	Superior long-term patency with greater saphenous vein	Longer hospital length of stay
	Can seal off geniculate arteries with posterior approach	Higher rates of morbidity and mortality
Endovascular repair	Less invasive and less morbidity	Higher rates of thrombosis and reintervention
	Decreased operative time and hospital length of stay	Lower rates of long-term patency
		Must be on clopidogrel
		Higher associated costs

Abbreviation: PAA, popliteal artery aneurysm.

higher rates of reintervention compared with open repair.[43] Furthermore, endovascular repair trended toward higher rates of major adverse effects at 3 years, although not significant.

Several recent meta-analyses have investigated the differences in outcome between open and endovascular repair. Shahin et al demonstrated that open surgical repair was associated with greater 1-year primary patency as well as lower rates of graft occlusion and reintervention compared with stent graft repair.[40] Leake et al reported similar findings, with open repair having higher rates of primary patency at 1 and 3 years, with a mean 3-year patency of 79.4%.[41] Secondary patency at 1 and 3 years were not significantly different. There was no overall difference in 30-day complications, although endovascular repair was associated with less wound complications. Comorbidities were similar in both groups, although patients who received open repair were younger and had worse runoff. A study comparing patency demonstrated that at 2 years, vein bypass had the best primary patency at 94.9%, compared with polytetrafluoroethylene (PTFE) and stents grafts, which were 79 and 70.7%, respectively.[26] Long-term follow-up at 54 months demonstrated primary patency of 78% for vein bypass compared with 54.9% for prosthetic.

Hogendoorn et al used decision analysis with a Markov model to compare open and endovascular treatment for asymptomatic popliteal aneurysms.[44] Compiling data from prior published studies on open and endovascular repair, they demonstrated that for a 65-year-old male with minimal comorbidities with a 2.0-cm asymptomatic PAA, an open bypass with greater saphenous vein remains the gold standard (►**Table 1**). Compared with covered stent placement, bypass with greater saphenous vein had significantly higher quality-adjusted life-years (►**Fig. 4**). Furthermore, covered stent placement was associated with higher costs and more reinterventions. When there was no suitable autologous conduit, a bypass with PTFE was found to be inferior to covered stent placement. Use of a covered stent was also superior to open repair for patients who were high risk for open repair with a greater than 6% 30-day mortality. A male patient with common comorbidities including hypertension, diabetes mellitus, smoking, and cardiovascular status had a 1.4% risk of perioperative mortality. Importantly, medical therapy was found to be the preferred treatment over any intervention (open or endovascular) for patients older than 95 years old or with a life expectancy of less than 1.5 years. As stated in the study, although it may be difficult to accurately prognosticate a patient's life expectancy, such a number can serve as a guide for difficult treatment decisions.

There is a paucity of randomized controlled trial data comparing open and endovascular repair for asymptomatic PAAs. Antonello et al provided the only prospective randomized trial comparing open and endovascular repair.[45] Primary patency at 1 year was 100% for open repair compared with 86.7% for endovascular repair, with a secondary patency rate of 100%. Operative time and length of stay were significantly shorter in the endovascular arm. However, the trial was underpowered, with 15 patients in each treatment arm. Furthermore, 26.7% of the bypasses used PTFE as the conduit. The ongoing Open versus Endovascular Popliteal Artery Aneurysm Repair (OVERPAR) trial will hopefully help delineate the differences between open and endovascular repair.[46]

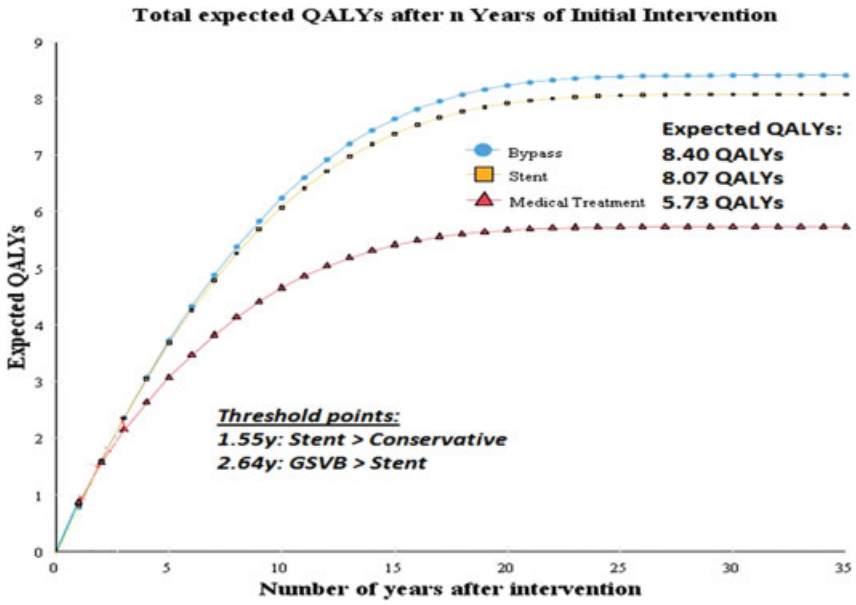

Fig. 4 Total expected quality-adjusted life-years (QALYs) for greater saphenous vein bypass (GSVB), stenting, and optimal medical therapy (OMT) at the age of initial intervention. Adapted from Hogendoorn et al.[44]

Overall, open repair with venous conduit is associated with the best patency (►**Table 2**). Prosthetic conduit demonstrated similar or worse outcomes compared with stent grafts. Almost all the data comparing open and endovascular repair demonstrated that stent graft placement has comparable short- and mid-term outcomes, although it is associated with greater rates of graft occlusion and reintervention. Thus, in a young patient with minimal comorbidities, open repair with venous conduit still remains the gold standard. However, endovascular repair with stent graft placement remains an important treatment choice for older patients with multiple comorbidities, although close follow-up is recommended due to decreased patency and higher rates of reintervention.

Conclusion

As endovascular techniques and technology advance, it is likely that patency and outcomes will continue to improve, further challenging the status of open surgical repair as the gold standard. For now, open surgical repair is the preferred choice of repair for asymptomatic PAA provided there is available venous conduit in younger, active patients without significant comorbidities. Endovascular repair is appropriate for patients without good venous conduit, or in older patients with several comorbidities placing them at high risk. Furthermore, consideration should be given to a patient's overall condition and life expectancy, as no benefit from repair may be observed. A randomized controlled trial with long-term follow-up is necessary to identify which patients would benefit most from either treatment option.

Conflict of Interest
None.

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